

INTERSPECIFIC ASSOCIATION OF JACANAS (*HYDROPHASIANUS CHIRURGUS* AND *METOPIDIUS INDICUS*) AND THE ROLE OF HABITAT¹

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(With five text-figures)

Key words: *Metopidius indicus*, *Hydrophasianus chirurgus*, interspecific association, habitat similarity, spatial affinity, flocking.

The interactions of the pheasant-tailed jacana *Hydrophasianus chirurgus* and the bronzewinged jacana *Metopidius indicus* with other avian species were studied in a tropical monsoonal wetland in Bharatpur, Rajasthan, India. All together 25 and 29 species of birds were recorded in the proximity of the pheasant-tailed and the bronzewinged jacanas respectively. The pattern of occurrence of the pheasant-tailed and the bronzewinged jacanas with all other avian species was non-random and the nature (direction) of association was characterized as negative, because the frequency of occurrence of jacanas with the other avian species was fewer than their frequency of sighting alone. Season-wise data on bronzewinged jacana also showed non-random pattern and negative association. The role of habitat preference of both the species of jacana and their associated species was studied to determine the nature of their association. Those species which were similar to bronzewinged jacana in their habitat preference had lesser degree of association (spatial affinity) with it because the habitat patches were available in plenty. No predation on adult of both species occurred, except on the eggs of the pheasant-tailed jacana by the marsh harrier (*Circus aeruginosus*) during the study period. The agnostic behaviour of both the species of jacanas and the importance of flocking in the pheasant-tailed jacana as an anti-predatory strategy have also been discussed.

INTRODUCTION

The three broader categories of interspecific association, namely negative, positive and none, and assumed to be the response of a species to its abiotic and biotic factors (Ludwig and Reynolds 1988). The positive association between two species may result from a common response to environmental factors, a behavioural (social) cohesiveness between the species or from a behavioural or ecological repulsion from other areas forcing individuals to

co-occupy the same general sets of conditions. Negative associations, on the other hand, may result from differences in habitat preference, behavioural exclusion or repulsion, or effect of past population histories (Pielou 1972; Hubalek 1982).

Studies on the interspecific association among birds in India are very few (Vijayan 1984; Rahmani and Manakadan 1987). In jacana species, interspecific grooming and possible mutualistic interaction of wattled jacana with *Capybara Hydrochoerus hydrochaeris* was reported (Marcus 1985). To date, there is no systematic study on the interactions of jacanas with other avian species. Therefore, a study was carried out for a period of three years since 1985 with the objective of recording, quantifying and

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characterising their interactions with other avian species.

receives water annually from a reservoir - Ajan bund, situated about 500 m south of the Park.

STUDY AREA

The study was conducted in Keoladeo National Park, Bharatpur, a man-modified wetland studied in the Indogangetic plains. The Park is situated between 27° 7.6' and 27° 12.2' N, and 77° 29.5' and 77° 33.0' E in Rajasthan. The total area of the Park is 29 sq. km and out of this 8.5 sq. km is covered by water during the years of normal rainfall and water supply. The aquatic portion of the Park has been divided into various unequal compartments or blocks by means of dykes (Fig. 1). The aquatic and semi-aquatic plants provide the Park with spatial heterogeneity which is very important for supporting and maintaining diverse avifauna. 115 species of aquatic birds have been recorded from this area (Ramachandran 1993). The Park

METHODOLOGY

Observations were made walking along the dykes using binoculars at different times of the day to cover various activities of the species. Habitats or vegetation patches were distinguished using the dominant vegetation. These vegetation patches were considered as the natural sampling units or discrete habitable units (Pielou 1977). When the area of the vegetation patch was very large (>10 m²), then observations were made within a 10 m radius of the jacana. This situation arose only in the case of a superabundant species of grass *Paspalum distichum*. All the species found along with jacanas in each vegetation patch were counted and recorded. The habitat type and activity were also recorded for all the species within the sampling unit.

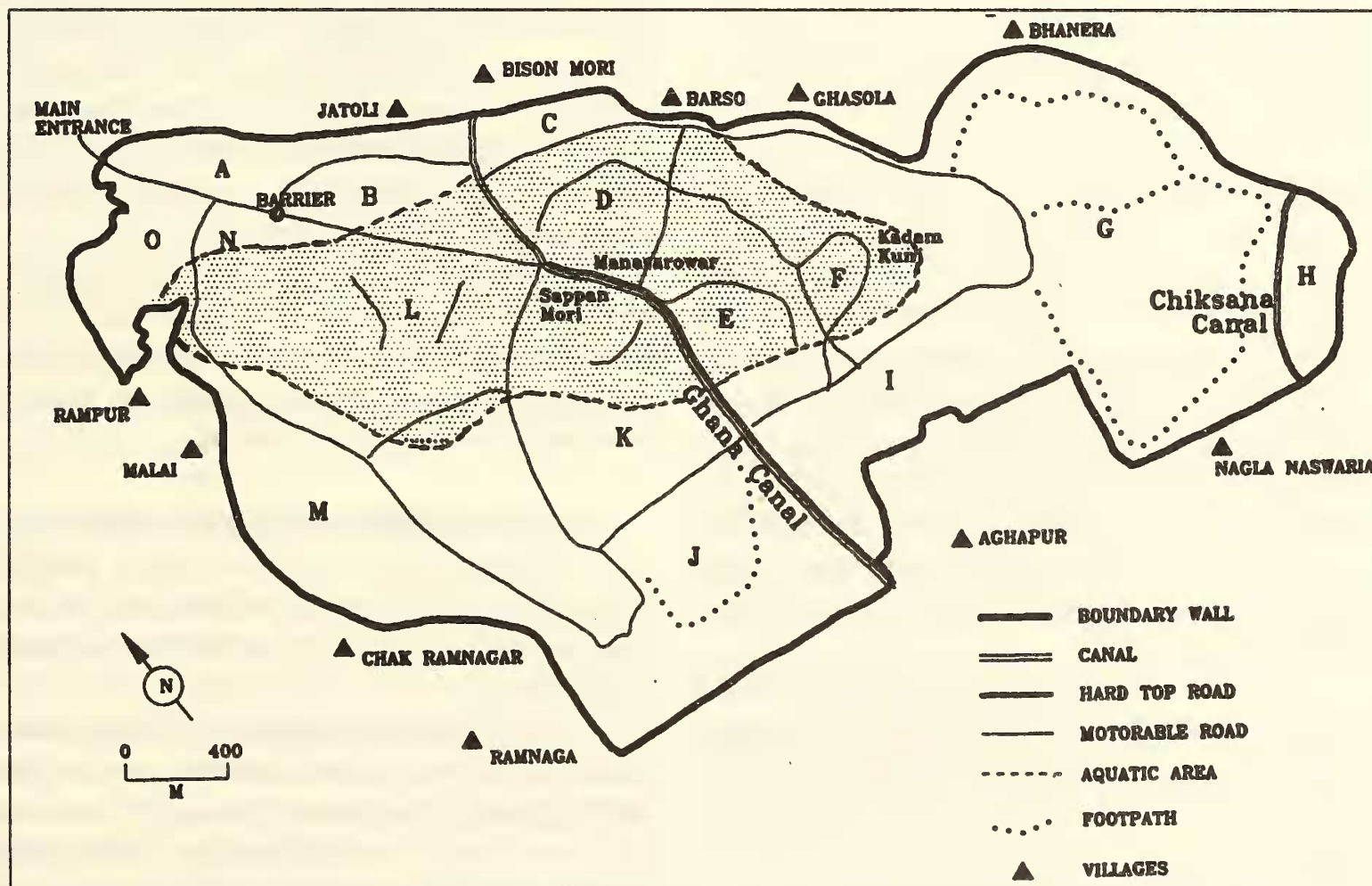


Fig. 1. Map of Keoladeo National Park, Bharatpur, Rajasthan, a man-modified wetland

The habitat similarity and spatial affinity were computed. The spatial affinity is a measure of how often two species occur together. This is a measure of association or congregation or temporary grouping of individuals in a foraging area.

STATISTICAL ANALYSIS

To test the hypothesis that the pattern of occurrence of jacanas with or without other species is random, a chi-square test was carried out (Sokal and Rohlf 1981). Once the pattern is proved non-random, the type of interaction was attributed as positive or negative, based on the frequency in both classes. Positive nature was attributed when the frequency of the jacana occurring with a particular species was greater than when it was without the same species. Similarly negative nature was attributed when the case was in the reverse. Data were pooled into three seasons, namely summer (March, April, May and June) monsoon (July, August, September and October) and winter (November, December, January and February) in the case of the bronzewinged jacana. This was done to account for the status of the associated species (i.e. migratory, local resident and locally moving resident). The seasonal break-up of data was done only for the bronzewinged because they occurred through all the seasons, whereas the pheasant-tailed occurred only in monsoon and winter and hence no seasonal treatment of data was attempted. Those species which occurred less than five times are also included in the analysis to represent all the species, although their inclusion is not allowed on statistical grounds (Greig-Smith 1983).

The spatial affinity or the degree of association and the similarity in habitat utilization pattern of jacana and the associated species were expressed as an index of similarity (Bray and Curtis 1957).

$$\text{Similarity index} = 2W / (A + B)$$

where W is the sum of the lesser values of abundance in the two species compared, A and B are the sum of abundances of each species. The value of similarity ranges from 0 (for no similarity) to 1 (for complete similarity). In spatial affinity analysis each sighting is treated as such, so that the influence of their spatial pattern within the habitat can be accounted for. In order to examine the role of habitat preference of jacanas and the associated species in their association, their habitat preference was compared by pooling the data habitat-wise and calculating the similarity.

RESULTS

Association of the Pheasant-tailed Jacana:

The pheasant-tailed was present in good numbers only during the monsoon and winter of 1986 and 1987, hence data collected only during those periods were taken for analysis. Even during those seasons their population was not as high as in previous years. Therefore, the pattern of association derived from the data may not be conclusive. Nevertheless, it indicates the trend. On the whole 198 observations were made and a total of 25 species were recorded with the pheasant-tailed jacana (Table 1).

Association of the pheasant-tailed jacana with all other species was non-random, and in all cases frequency of occurrence with each species was less than that of without those species, thus the association was negative (Table 1).

Spatial affinity and habitat similarity:

The pond heron *Ardeola grayii* has the highest affinity followed by cattle egret *Bubulcus ibis*. Another 13 species did not have any affinity at all (Fig. 2).

The habitat use pattern of the pheasant-tailed jacana was more similar to that of the greylag goose *Anser anser* followed by common teal *Anas crecca*, coot *Fulica atra*, little grebe *Podiceps ruficollis* and the bronzewinged jacana (Fig. 2). Among the rest, while a group of species

TABLE 1

SPECIES RECORDED ALONG WITH THE PHEASANT-TAILED JACANA AND THE CHI-SQUARE ANALYSIS FOR TESTING THE NULL HYPOTHESES THAT THE PATTERN OF THEIR OCCURRENCE WITH AND WITHOUT OTHER AVIAN SPECIES IS RANDOM. EXPECTED FREQUENCY = 99.

Associated avian species		Status	Frequency of occurrence of pheasant-tailed Jacana		Ch2*
Common Name	Scientific Name		With other species	Without species	
Large Egret	<i>Ardea alba</i>	R	3	195	186.18
Pintail	<i>Anas acuta</i>	M	10	188	160.02
Greylag Goose	<i>Anser anser</i>	M	1	197	194.02
Grey Heron	<i>Ardea cinerea</i>	R	11	187	156.44
Shoveller	<i>Anas clypeata</i>	M	16	182	139.17
Common Teal	<i>Anas crecca</i>	M	11	187	156.44
Pond Heron	<i>Ardeola grayii</i>	R	6	192	174.72
Purple Heron	<i>Ardea pupurea</i>	R	4	194	182.32
Spotbill	<i>Anas poecilorhyncha</i>	R	3	195	186.18
Gadwall	<i>Anas strepera</i>	M	4	194	182.32
Cattle Egret	<i>Bubulcus ibis</i>	R	1	197	194.02
Marsh Harrier	<i>Circus aeruginosus</i>	M	2	196	190.08
Lesser Whistling Teal	<i>Dendrocygna javanica</i>	R	1	197	194.02
Median Egret	<i>Egretta intermedia</i>	R	9	189	163.63
Coot	<i>Fulica atra</i>	M	26	172	107.65
Indian Moorhen	<i>Gallinula chloropus</i>	R	5	193	178.5
Siberian Crane	<i>Grus leucogeranus</i>	M	1	197	194.02
Blackwinged Stilt	<i>Himantopus himantopus</i>	M	1	197	194.02
Pallas's Fishing Eagle	<i>Haliaeetus leucoryphus</i>	M	1	197	194.02
Bronzewinged Jacana	<i>Metopidius indicus</i>	R	30	168	96.18
Cotton Teal	<i>Nettapus coromandelianus</i>	R	8	190	167.29
Purple Moorhen	<i>Porphyrio porphyrio</i>	R	6	192	174.72
Little Grebe	<i>Podiceps ruficollis</i>	R	3	195	186.18
Wood Sandpiper	<i>Tringa glareola</i>	M	2	176	119.77
Whitetailed Lapwing	<i>Vanellus leucurus</i>	M	1	197	194.02

* $Chi^2 > Chi^2_{0.05}$ and hence all null hypotheses are rejected.
R = Resident; M = Migrant

whose values ranged from 0.06 to 0.01 showed very little similarity, another group showed no similarity at all.

Agnostic interactions of the Pheasant-tailed Jacana:

The marsh harrier *Circus aeruginosus* was the main predator of the pheasant-tailed jacana during 1988, preying mainly on the eggs. During 1986 and 1987, pheasant-tailed jacana were not breeding inside the Park and their population was also low. Hence the intensity of predatory interactions was also less.

During 1986, pheasant-tailed jacana foraged in flocks of eight to thirteen. Being a

polyandrous species, it has to form groups to facilitate breeding. The grouping or flocking is also an anti-predatory tactic and has been reported in many bird species (Page and Whitacre 1975, Kenward 1978, Bertram 1980). The pheasant-tailed becomes alert on the advance of a raptor, usually from the alarm calls and the subsequent evading flights of another pheasant-tailed or member of any associated species feeding in the vicinity. The pheasant-tailed, being in the vicinity of other species, benefited in getting early warnings.

On hearing or seeing the warnings either from the member of the same species or from other species of birds in the vicinity, jacanas

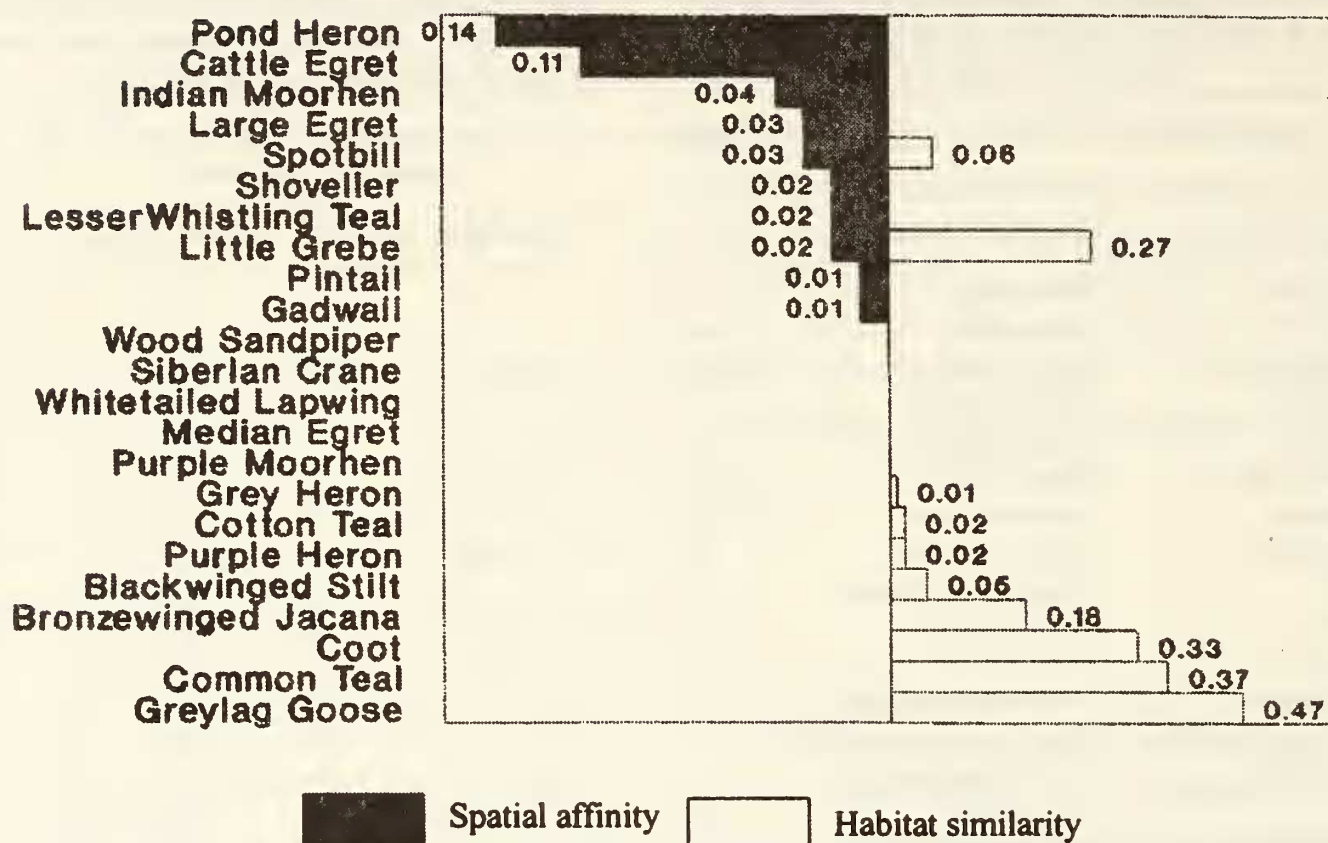


Fig. 2. Spatial affinity and habitat similarity of different avian species with pheasant-tailed jacana

always made aerial escape. They remained on the wing for a while and later settled in the same place or in another patch.

Association of the Bronzewinged Jacana with other species:

Altogether 29 species were sighted along with the bronzewinged jacana during the period of study (Table 2). The number of bird species sighted along with the bronzewinged jacana did not vary much during winter and monsoon, being 24 and 22 respectively, whereas in summer it did vary considerably. The majority of species associated with jacana were resident in all the three seasons. Only seven species were sighted along with the bronzewinged jacana during summer, out of which the wood sandpiper was the only migrant which usually leaves the wintering ground very late (Table 1). The decrease in number during summer was due to the following factors: (1) all the migratory species left the park towards the end of March, and (2) many of the resident species started moving out

of the Park in summer as the Park dried up.

The chi-square test on four categories of data sets, i.e. winter, monsoon, summer and the total study period revealed a non-random pattern and, in all cases had negative association, as the frequency of occurrence of the bronzewinged jacana without other species was greater than that with the other species (Table 2).

Spatial affinity and habitat similarity during winter, summer and monsoon:

WINTER: During winter, the highest spatial affinity recorded was for the Indian moorhen *Gallinula chloropus* followed by grey heron *Ardea cinerea* and pheasant-tailed jacana (Fig. 3).

The habitat utilization pattern of the whistling teal *Dendrocygna javanica* had the highest similarity with that of the bronzewinged jacana, followed by the yellow wagtail *Motacilla flava* (Fig. 3). Median egret *Egretta intermedia* and shoveller *Anas chrypeata* showed no similarity to the bronzewinged jacana in their habitat utilization pattern.

TABLE 2
THE CHI-SQUARE ANALYSIS FOR TESTING THE HYPOTHESES THAT THE PATTERNS OF OCCURRENCE OF THE
BRONZEWINGED JACANA WITH AND WITHOUT OTHER AVIAN SPECIES ARE RANDOM

Associated avian species		Status	Whole period Exp. fr. = 337.5		Winter Exp. fr. = 141.5		Monsoon Exp. fr. = 188.5		Summer Exp. fr. = 7.5		
Common Name	Scientific Name		With	Without	Chi	With	Without	Chi	With	Without	Chi
Blackwinged Stilt	<i>Himantopus himantopus</i>	M	1	674	671	1	282	279			
Cattle Egret	<i>Bubulcus ibis</i>	R	4	671	659	10	367	338			
Comb Duck	<i>Sarkidiornis melanotos</i>	R	1	674	671	1	282	279			
Common Teal	<i>Anas crecca</i>	M	28	647	567	20	263	208	8	369	345
Coot	<i>Fulica atra</i>	M	50	625	489	48	235	123	2	375	369
Cotton Teal	<i>Nettion coromandelianus</i>	R	15	660	616	15	362	319			
Gadwall	<i>Anas strepera</i>	M	6	669	651	6	277	259			
Grey Heron	<i>Ardea cinerea</i>	R	17	658	608	7	276	255	9	368	341
Indian Moorhen	<i>Gallinula chloropus</i>	R	85	590	377	29	254	178	55	322	189
Large Cormorant	<i>Phalacrocorax carbo</i>	R	1	674	671	1	376	373	1		14
Large Egret	<i>Ardea alba</i>	R	1	674	671	1	376	373	1		14
Lesser Whistling Teal	<i>Dendrocygna javanica</i>	R	12	663	627	4	279	267	8	369	345
Little Egret	<i>Egretta garzetta</i>	R	2	673	667	1	376	373	1	14	11
Little Grebe	<i>Podiceps ruficollis</i>	R	1	674	671	1	282	279			
Marsh Harrier	<i>Circus aeruginosus</i>	M	10	665	635	2	281	275	2	375	369
Median Egret	<i>Egretta intermedia</i>	R	29	646	563	10	273	244	19	358	304
Pheasant-tailed jacana	<i>Hydrophasianus chirurgus</i>	R	22	653	589	19	264	212	3	374	365
Pied Myna	<i>Sturnus contra</i>	R	8	667	643	2	281	275	5	372	357
Pintail	<i>Anas acuta</i>	M	15	660	616	15	268	226	1	376	373
Pond Heron	<i>Ardeola grayii</i>	R	53	622	479	20	263	208	30	347	266
Purple Heron	<i>Ardea purpurea</i>	R	19	656	601	4	279	267	15	362	319
Purple Moorhen	<i>Porphyrio porphyrio</i>	R	13	662	624	8	275	251	5	372	357
Redwattled Lapwing	<i>Vanellus indicus</i>	R	1	674	671	1	14	11			
Shoveller	<i>Anas clypeata</i>	M	22	653	589	21	262	205	1	376	373
Darter	<i>Anhinga rufa</i>	R	3	672	663	1	282	279	2	375	369
Spotbill	<i>Anas poecilorhyncha</i>	R	4	671	659	4	279	267			
Whitebreasted Waterhen	<i>Amaurornis phoenicurus</i>	R	9	666	639	2	281	275	7	370	349
Wood Sandpiper	<i>Tringa glareola</i>	M	43	632	513	13	270	233	29	348	269
Yellow Wagtail	<i>Motacilla flava</i>	M	1	674	671	1	282	279	1		14

Chi² > Chi²_{0.005} and hence all null hypotheses are rejected; R = Resident; M = Migrant

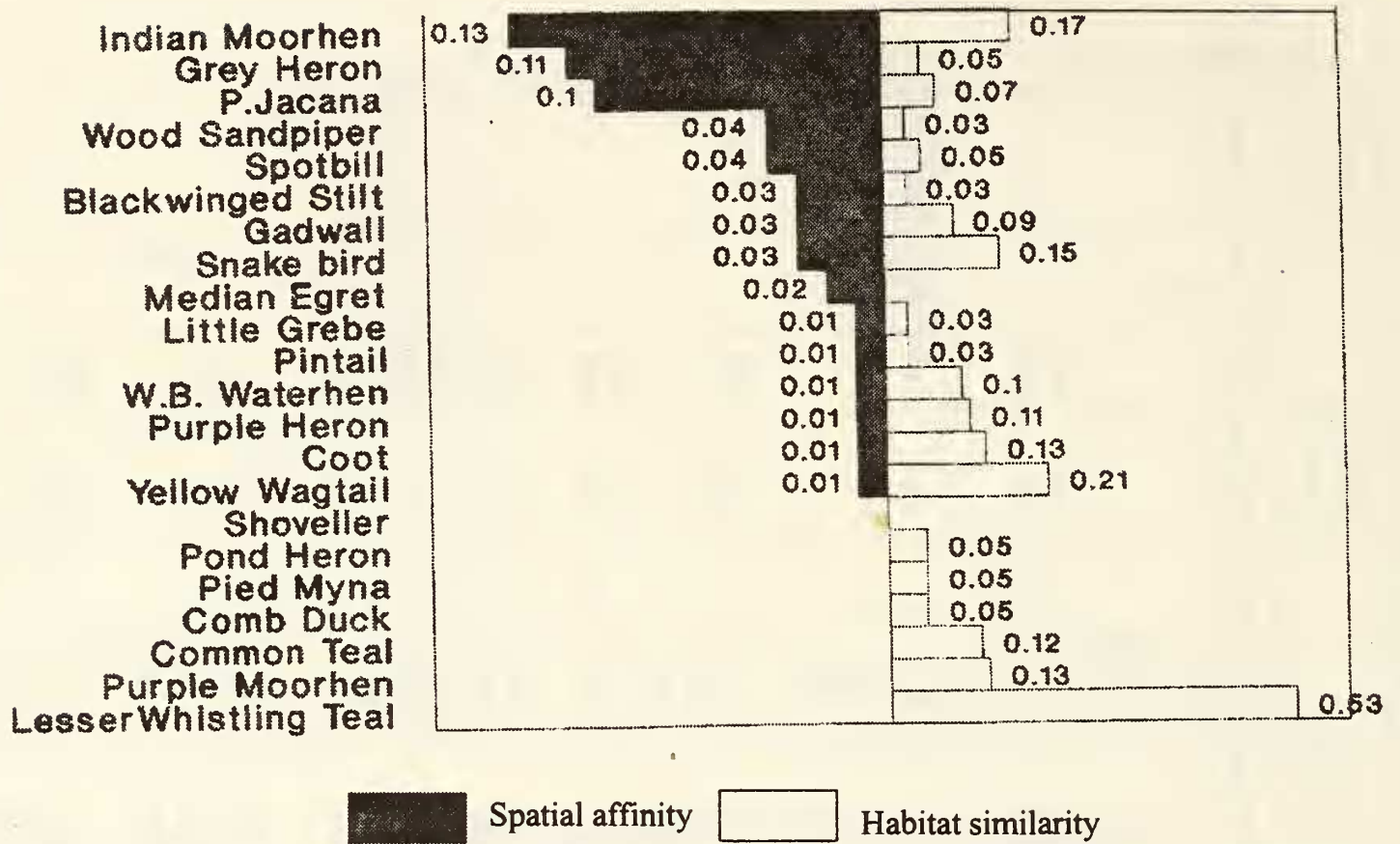


Fig. 3. Spatial affinity and habitat similarity of different avian species with bronzewing jacana during winter

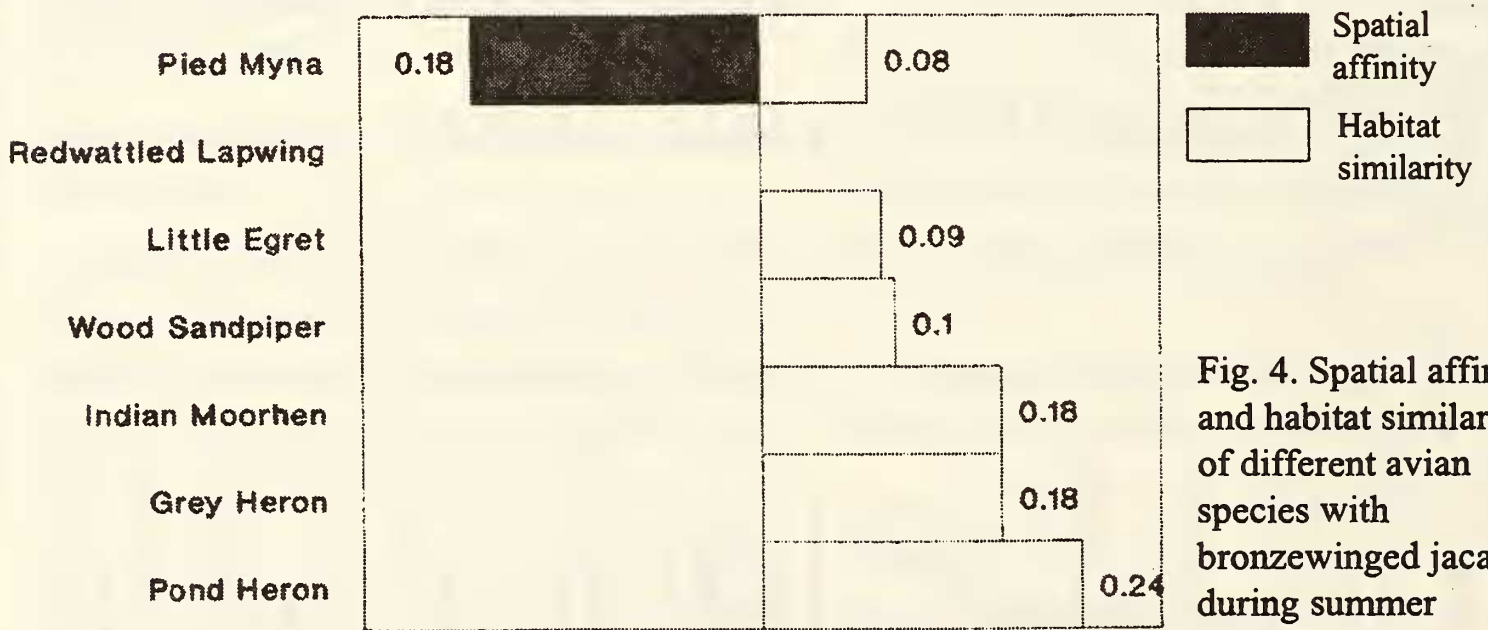


Fig. 4. Spatial affinity and habitat similarity of different avian species with bronzewing jacana during summer

SUMMER: The pied myna *Sturnus contra* had the highest affinity towards the bronzewing jacana during summer, as the former came in flocks to the drying marshes for foraging, and got associated with the bronzewing jacana (Fig. 4). The rest of the associated species had no affinity towards the

bronzewing jacana. The habitat utilization pattern of the pond heron showed higher similarity with that of the bronzewing jacana (Fig. 4).

MONSOON: The highest affinity during monsoon was shown by the little egret *Egretta garzetta*, followed by wood sandpiper *Tringa*

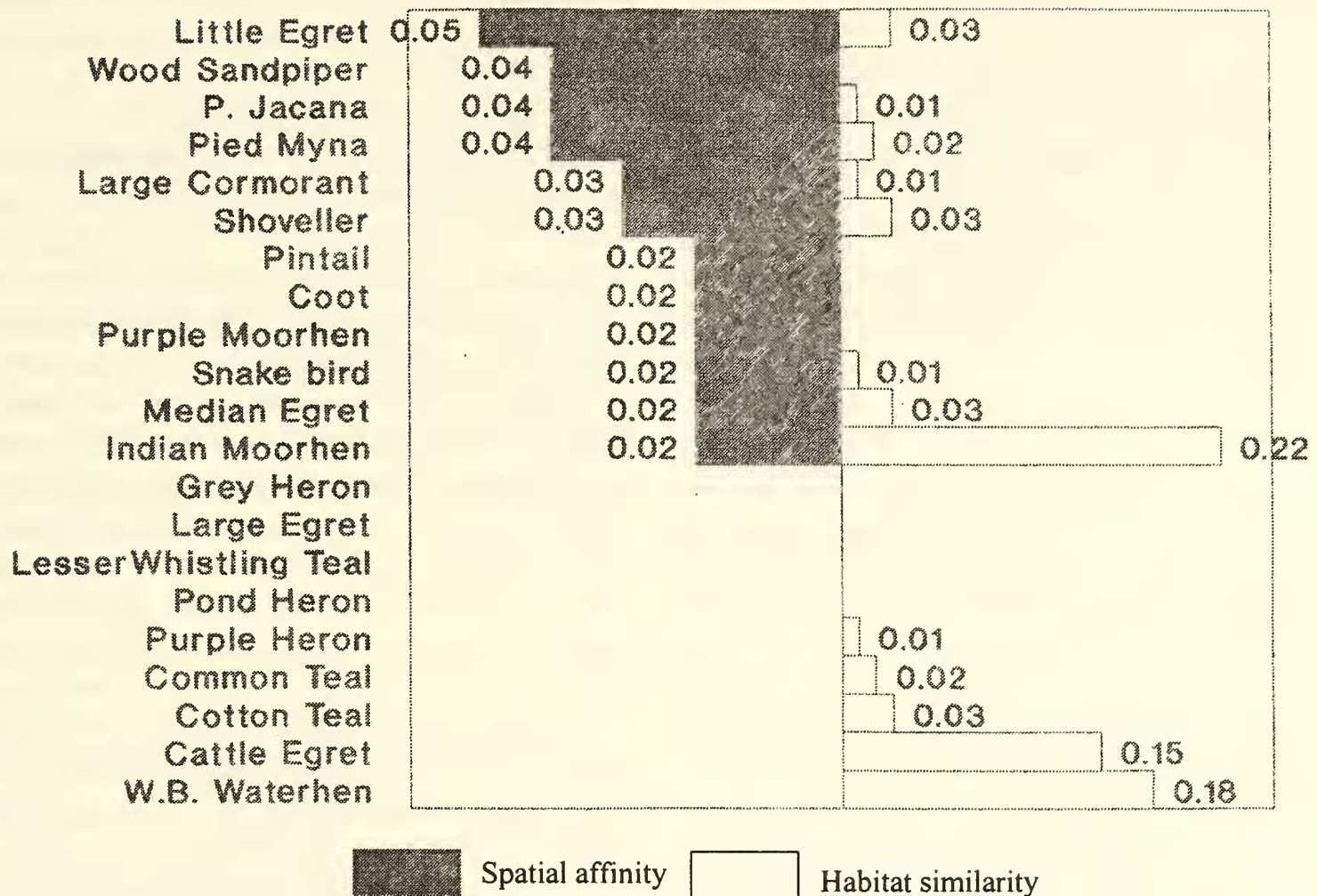


Fig. 5. Spatial affinity and habitat similarity of different avian species with bronzewinged jacana during monsoon

glareola, pheasant-tailed jacana and pied myna (Fig. 5). The Indian moorhen showed the highest similarity in habitat use pattern to the bronzewinged jacana (Fig. 5).

The values of spatial similarity and habitat similarity were insignificant in all the seasons. However, the pattern obtained is worth mentioning; the values of spatial affinities in different seasons reveal that none of the species had shown consistent affinity throughout the season. This is more clear during winter and monsoon. If the species were consistently showing more or less the same affinities towards bronzewinged jacana during both the seasons, they could be interpreted as associated. But the case was reverse, which further corroborates the result obtained from the association analysis.

Agnostic interaction of the Bronzewinged Jacana:

Agnostic interspecific interactions in the bronzewinged jacana were noted only in the breeding season, which is associated with the protection of young ones. On one occasion they were found chasing away the Indian moorhen. Mathew (1964) reports that they chase away waterhen *Amaurornis phoenicurus* and pond heron. Chattopadhyay (1981) narrated an incident in which the bronzewinged jacana aggressively defended an injured chick from intruders, namely cotton teal *Nettapus coromandelinus*, lesser whistling teal, pheasant-tailed jacana, whitebreasted kingfisher *Halcyon smyrnensis* and little grebe. In the present study, no such interactions were observed against these species, probably because they are not

actual predators. Only the marsh harrier, which is an important predator of this bird was found eliciting an aggressive response from this bird and on one occasion a harrier was physically assaulted by the bronzewinged in defence of its chick. This type of antipredator behaviour was reported in Northern jacana *spinosa* against the American purple gallinule *Gallinula martinica* which is a predator of its eggs (Stephens 1984a, 1984b).

DISCUSSION

Pielou (1972) discussed three ways by which negative association is effected: (1) differences in habitat preferences, (2) behavioural exclusion or repulsion and (3) effect of past population histories. In jacanas, difference in habitat preference resulted in negative association in some cases, whereas in certain cases this is through spatial segregation.

A comparison of the values of spatial affinity with those of habitat similarity of the associated species revealed that in general the species with higher affinity values had lower habitat similarity with the pheasant-tailed jacana (Fig. 2). The bronzewinged also reflect almost the same trend in all three seasons (Figs. 3, 4 & 5). This indicated that resources (vegetation patches) are abundant for those species having higher overlap with the jacanas and therefore, they spatially distribute each other in such a way resulting in negative association. Nevertheless, the pattern obtained for the bronzewinged jacana during winter did not clearly show this relationship (Fig. 5), for there are birds showing medium tendencies in their relationship between spatial affinity and habitat similarity. This may either be due to the high density of the associated species or the limited patch availability.

The marsh harrier seems to be the only important predator of bronzewinged jacana. This bird invited aggressive physical assault from the bronzewinged and this type of direct

antagonistic reaction is reported in Northern jacana also against the purple gallinule (Stephens 1984a, 1984b).

Flocking is an anti-predatory tactic in many bird species (Page and Whitacre 1975, Kenward 1978, Bertram 1980). Here, the Flock is defined as a semipermanent cohesive group of individuals of the same species, showing synchronized behaviour. The pheasant-tailed jacana forms only single species flocks. Birds in flocks may be safer than solitary individuals for at least three reasons (i) individuals in a group may detect predators better or earlier than smaller groups or solitary individuals (Pulliam 1973; Siegfried and Underhill 1975, Kenward 1978; Lazarus 1979), (ii) a predator which attacks a group of prey may become confused and catch fewer prey (Neill and Cullen 1974, Milinsky 1979; Randaue and Terborgh 1986), and (iii) an individual in a group may reduce its chance of being caught simply because of a dilution-effect (Foster and Treherne 1981, Powell 1974). Carco *et al.* 1980 predicted that small birds which live in flocks (<20) respond to increased risk of predation by increasing group size. The flock size of pheasant-tailed jacana ranged from 8 to 13 throughout the study period and no increase in the group size was noticed. Thirteen was the maximum population size during the winter of 1986. McWilliams *et al.* (1984) also did not observe flock size increase in cackling geese and Ross' geese (*Branta canadensis minima* and *Chen rossii*) in relation to increased predation risk. They suspect that the flock size of these species is primarily dictated by the distribution and abundance of food plants and the local population size of geese. It may be true in the case of pheasant-tailed jacana also, where the local population size would have decided the flock size.

CONCLUSION

The pattern of occurrence of the pheasant-tailed and bronzewinged jacanas with all other

avian species was non-random and the nature of association was characterized as negative, as the frequency of occurrence with other avian species was less than without them. The bronzewinged jacana, when treated season-wise, also showed non-random pattern and negative association.

Those species which showed higher similarity in their habitat preference to that of the bronzewinged jacana showed lesser affinity towards it. None of the species showed consistent affinity with bronzewinged jacana in any season, especially during monsoon and winter, which proves that they are negatively associated with it.

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